The fact that all of the mail-cheeked fishes do not have the coracoid elements separated by the actinosts is not an argument in disfavor of the relationship of the Gobiidæ to the Cottidæ, because the mail-cheeked fishes with the typical shoulder girdle (such as the Scorpænidæ) were, of course, the ancestors of the Cottidæ. From the Cottidæ came the Liparidæ and the Cyclopteryidæ, as Dr. Gill long ago pointed out.[1]

It does not seem improbable that the gobies may have come from some ancestor—probably scale-covered—of the Cottidæ in which the shoulder girdle had become differentiated. Further, it is not altogether improbable that this ancestor might also have been from somewhere along the line leading towards the Cyclopteryidæ and the Liparidæ; some form in which the ventrals had just become attached to each other, much as in most of the gobies of to-day. From this the sucking disk of the Liparidæ and Cyclopteryidæ could have developed. In considering this supposition, of course, we could only explain the gobies with separate ventrals by the separation being secondary. The gobies further resemble the last two families in having no myodome to the cranium.

It is conceded, certainly, that the family Gobiidæ is not very close to the Cottidæ, they having lost the suborbital stay to the preoperculum and undergone other changes, and no modification of the suborders containing these two families is suggested. The character of the shoulder girdle seems to be the most significant character in showing a possible line of descent of the gobies, and it is suggested in light of it that the group be placed in close relationship with the mail-cheeked fishes in works involving classification. With this question in mind the gobies should, of course, be studied in detail.

Edwin Chapin Starks

CARCHARIAS BORNEENSIS AND BARBUS ELONGATUS, AS PREOCCUPIED NAMES

In the *Philippine Journal of Science*, Vol. V, No. 4, Section D, October, 1910, p. 263, Pl. 1, Mr. Alvin Seale describes, as new, "*Charcharias borneensis.*" This is preoccupied by *Carcharias* (*Prionodon*) *borneensis* Bleeker, *Act. Soc. Sci. Ind.-Neerl.* (Borneo 12), V, 1858–59, p. 8.

In the same journal Mr. Seale also describes, as new, *Barbus elongatus*, on p. 265, illustrated on Pl. 2 as Fig. 1. This is preoccupied by *Barbus elongatus* Rüppell, Mus. Senckenb., II, 1837, p. 11, Pl. 2, Fig. 1.

Henry W. Fowler

Academy of Natural Sciences,
Philadelphia, Pa.,
February 9, 1911

[1] *Proc. U. S. Nat. Mus.*, Vol. XIII., 1890.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 693d meeting was held on April 8, 1911, President Day in the chair. Three papers were read.

Mechanical Forces on an Electrical Conductor: Dr. Frank Wenner, of the Bureau of Standards.

Starting with the equation for the electromotive forces in an inductive circuit the speaker showed how it follows under certain conditions that a current through a conductor causes forces such as to require a tension in the conductor to maintain equilibrium, that is, the forces tend to increase the length of the conductor. It also follows that under other conditions the forces are such as to tend to decrease the length of the conductor. Under most conditions the force on an element of the conductor near the surface is such as to tend to crowd it toward the center.

It was also stated that it is possible that a current in a conductor causes forces other than those due to electro-magnetic and electrostatic actions, the former only having been considered by the speaker. So far, however, no one has shown the presence of any such additional force.

The Completion of the Texas-California Arc of Primary Triangulation: Mr. Wm. Bowie, of the Coast and Geodetic Survey.

Three grades of triangulation are recognized: primary, secondary and tertiary; and the grade depends upon the accuracy of the angle and length measurements rather than upon the length of line between pairs of stations.

The primary work is extended in long arcs over

the area of a country to furnish control for the detailed operations. The tertiary is used for the immediate control of detailed topographic, boundary and other surveys, while the secondary triangulation is mainly for the purpose of connecting the detached tertiary work with the primary schemes.

Owing to the difference which must exist at every station between the geodetic position and the corresponding astronomic position, it is necessary to adopt a mean position called a geodetic datum upon which to reckon geographic positions over the entire country. It is the principal object of the primary triangulation to carry standard positions by a connected net to the remotest portions of the area.

An incidental purpose of triangulation, and especially of the primary, is to furnish means for determining the shape and size of the earth.

In the two recent investigations of the figure of the earth by Mr. John F. Hayford, while he was inspector of geodetic work and chief of the computing division in the Coast and Geodetic Survey, he applied Pratt's hypothesis of isostasy and he stated that the application of this theory nearly doubled the accuracy of the results.

Including about 2,000 miles by the Lake Survey, there are now approximately 11,000 miles of primary triangulation in the United States. Recently about 400 miles have been added each year. The latest addition is the Texas-California triangulation, an arc of over 1,200 miles in length. It extends from the 98th meridian triangulation in central Texas to the Pacific coast arc in the vicinity of San Diego. It carries standard positions into an area badly in need of control and adds very valuable data for use in a future investigation of the figure of the earth.

The probable errors of the observed directions are not available, as the office computations have not yet been made, but we may get a measure of the accuracy of the work by the size of the errors of closure of the triangles. The average closing error is 0.9 second of arc, and the maximum error is very little more than 3 seconds. This makes the accuracy equal to the average of the best half of the work previously done in the United States.

The observations for horizontal measures were made entirely on heliotropes or on signal lamps. No serious difficulty was encountered in observing over even the longest lines under average conditions. The longest line was 127 miles in length. Some of the heliotropes had reflectors 4 and 8 inches square but most of the reflectors were only 2½ inches in diameter. The signal lamps burned acetylene gas. They were the commercial automobile headlights, modified for use on a stand erected over the station.

Some years ago it was believed that a great many observations were necessary to get an accuracy represented by an average closing error of one second and that the observations should be made on a number of different days. In recent years only sixteen positions are used, making 32 pointings on each object. All the horizontal observations at each of many stations have been made in a single day without materially affecting the accuracy. In fact, the average accuracy of the work done under the present methods is greater than the average accuracy of the work previously done.

It has been found that the sun effect on the towers, in causing twist, is very slight with the present type of tower, and that the effect, if any, is practically eliminated from the results by the system (always employed) of having a determination depend upon observations made while revolving the instrument clockwise and then in the reverse direction immediately afterwards.

The instrument had one horizontal wire and two vertical ones which were 20″ apart. It is not necessary for the image to be absolutely stationary for, with practise, one can place the cross wires close to the mean position of the image, even though the object may subtend an angle of more than 20″ and move 10″ to each side of the mean position. Observations made under this condition seem to have about the average accuracy.

Where the country is flat and the line close to the intervening land the wind tends to cause a distortion of the image. It sometimes appears to flare to one side, the flaring being away from what seems to be the nucleus or center of the image. In nearly every case where an asymmetrical image is observed the flaring seems to be with the wind. Under such a condition it is difficult to make satisfactory observations. If the flaring portion of the image is given equal weight with the nucleus a constant error is introduced, while if this flaring part is given no consideration a constant error of the opposite sign is made. Such an image is a severe test of the skill of the observer.

A remarkable case of lateral refraction was encountered on the twenty-mile line joining stations Clayton and Kennard, in Texas. This line passed very close to the west slope of a flat-topped hill about two and a half miles from Clayton. Observations made during several days at Clayton

on Kennard while the wind was blowing from the slope across the line were very unsatisfactory. When observations were made over the line with the wind blowing across it towards the slope of the hill, they were of the required degree of accuracy. The total range in the values for the several observing periods for this direction was about 8″ of arc. During each observing period the range of the values for the sixteen pointings was small. It is believed that the air blown from the hill across the line was of a different temperature and was the cause of the lateral refraction.

The large errors in the observed directions of primary triangulation seem to be due to three principal causes. First, to the asymmetrical image of the light or heliotrope caused by wind when the line is low. Second, to lateral refraction, caused by a line passing close to a hillside or mountainside with the wind blowing from the slope across the line. Third, to the very unsteady lights when the instrument is low with the line passing close to the ground near the station. The first two causes produce constant errors, that is, each of the 32 measures is affected in the same direction. The last cause makes large accidental errors.

The Modern Potentiometer: Dr. W. P. WHITE, of the Geophysical Laboratory of the Carnegie Institution of Washington.

For many purposes it is desirable to avoid the slide wire. The construction of potentiometers of wide range in which only switches are used formerly presented difficulties, which have now been overcome. The modern all-switch potentiometer is characterized by three features: (1) the resistance is low, yet the switch contacts introduce no error; (2) the thermo-electromotive forces at the switch contact and elsewhere must not cause variations in the reading; (3) the change of setting must not change the resistance of the galvanometer circuit; this in order that the partial deflection method may be employed. These three characteristics can not only be readily secured, but can be obtained in a number of different ways, so that three different types of instrument possessing them are now possible.

The main point of difference practically is concerned with the question whether certain switch contacts shall come in the battery circuit or in the galvanometer circuit. If they are in the battery circuit, much more care must be given to keep their resistance low, but this arrangement is best for reducing the thermoelectro forces. With the contacts in the galvanometer circuit, their resistance is unimportant, and the instrument therefore requires less care and attention; the thermoelectric forces can be practically avoided by proper switch construction, so that this arrangement seems preferable in a majority of cases.

(The abstracts of the second and last paper are by their authors.)

R. L. FARIS,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 383d regular meeting was held April 1 in the lecture hall of the Cosmos Club with President David White in the chair and about a hundred persons present.

Under the heading brief notes and exhibition of specimens, F. V. Coville showed a pot of trailing arbutus (*Epigæa repens*) in full bloom. The plant had been grown in the greenhouse from the seed, and ooth foliage and blossoms were superior to those commonly found wild.

The following communications were presented:

A Day in the Galapagos Islands: WILLIAM EDWIN SAFFORD.[1]

The arboreous cereus of Charles Island has never been adequately described. It was said by Darwin to resemble *Cereus peruvianus* and compared by Engelmann with *Cereus multiangularis*. It is quite distinct from both these species. The well-known *C. peruvianus* has only six to eight longitudinal ribs, while the Charles Island Cereus has sixteen to eighteen ribs. It is doubtful whether *C. multiangularis* is ever arboreous. Weber has described the Charles Island cereus under two names: *Cereus thouarsii*, which he characterizes as a columnar cereus with superimposed joints and pleasantly acidulous purplish-red, plum-like fruit containing soft white pulp and numerous small black seeds; *Cereus galapagensis*, as a plant resembling the arboreous cerei of South America, "with elevated angular stems exceeding the surrounding vegetation." Both of these descriptions apply well to the Charles Island cereus, illustrations of which, in flower, were presented by the author of the paper. The descriptions of both supposed species were published on the same page by Weber, and though *C. galapagensis* may be a preferable name, as it indicates the habitat of the species, *C. thouarsii* precedes it on the page, and must therefore be accepted.

Cereus thouarsii is remarkable for the long slender tube of its funnel-shaped perianth. The

[1] This paper is to be published in *The National Geographical Magazine.*

flowers are borne not near the apex, as in our giant cereus of Arizona, but along the sides of the branches and stems, often growing from areoles of the older or lower joints, solitary, yet often appearing from two or three adjacent areoles. The ripe fruits are very much like the *pitahayas* sold in Mexican markets. They are crowned by the withered perianth.

The joints, appearing in series and separated by abrupt constrictions, are sometimes five or six feet long, shaped like great ears of corn, or like thick-handled ten-pins or indian-clubs, or they are shorter and oval, resembling a series of melons piled one on top of the other, or they are sometimes spheroid, and the branches often form a divarication from one of the globose articulations. From the illustrations presented it is apparent that the arboreous cereus of Chatham Island is identical with that of Charles Island. It is to be regretted that figures of the flowers of Galapagos Cactaceæ are absolutely wanting thus far, though the islands have been repeatedly visited by scientific expeditions. The older specimens of *C. thouarsii* have stout cylindrical trunks covered with bark which splits into longitudinal strips.

The first description of an arboreous cereus growing in the Galapagos is that of the navigator Dampier, who visited the group in 1684. He described it as "a green prickly shrub ten to twelve feet high, as big as a man's leg and full of sharp prickles in thick rows from top to bottom, but without leaf or fruit." Colnett, in 1793, distinguished the cereus from the opuntia observed by him in the Galapagos, calling the first a "torch thistle" and the second a "prickly pear."

Captain David Porter was the first writer to call attention to the differences of the tortoises on the different islands of the Galapagos. His journal of the *Essex* was published twenty years before the visit of the *Beagle*. Figures were presented of two of the living tortoises from the Galapagos now in the National Zoological Park, *Testudo ephippium*, an example of what Captain Porter called the saddle-backed form, and *Testudo vicina* Guenther, with a back of the form likened by Woods Rogers, the old sea-rover, to the top of an old-fashioned hackney coach.

The figure of a fossil species, *Testudo osborniana* Hay, from the Miocene of northeastern Colorado, was also shown, and the question as to the possible connection of the Galapagos group with the main land during some part of the Tertiary age was discussed. The fact recorded by Captain Porter that tortoises thrown overboard from captured vessels remained floating and unharmed for several days, though unable to swim, was cited as bearing upon the point of the possible translation of the ancestors of the tortoises from the continent to the islands by ocean currents.

The paper ended with an account of the writer's visit to a hermit living in a cave in the interior of Charles Island, and of the animals which had become wild on the island, some of which had been caught when young and domesticated by the hermit. An account of the garden cultivated by the hermit was also given.

The Keys, Corals and Coral Reefs of Florida: T. WAYLAND VAUGHAN.

Dr. Vaughan gave a short lecture, illustrated by stereopticon views, on the subjects indicated by the title of his communication. He called attention to the extensive submarine plateau, of which the present land surface of Florida constitutes less than one half, and lies near the eastern margin. He briefly described the course of the 100-fathom curve and the steep declivity from it to the depth of 1,500 and 2,000 fathoms in the Gulf of Mexico, whereas between peninsular Florida and Cuba (except north of Havana) the depths are less than 500 fathoms. Between the northern end of the Bahama bank and the east coast of Florida the depth is somewhat less than 300 fathoms. The course of the 10-fathom curve was traced, and the relations it bears to the great barrier reef of Florida were indicated. The Hawk Channel, which lies between the line of reefs and the keys, the keys, and the bays and sounds between the keys and the mainland, were briefly described. A series of photographic slides were shown to illustrate the topography and geology of the mainland in the vicinity of Miami, and the surface features, including the vegetation, of the entire line of the Florida keys. The geologic formations of the region are of Pleistocene or recent age. The keys from Virginia Key at the north to Bahia Honda are elongated in a curve from northeast to southwest. Then follows the second group of keys including the Pine Keys, and extending to Boca Grande west of Key West are elongated in a direction at right angles to the axis of elongation of the more northerly keys; while the Marquesas and the Dry Tortugas are of atoll form. In composition the keys opposite the northern end of Bay Biscayne have a surface largely of siliceous sand. Those from Soldiers Key to the southern end of Big Pine Key are composed of elevated coral-reef rock—the Key Largo limestone. The keys from the Pine Keys

to Boca Grande are composed of an oolitic limestone—the Key West oolite, which has been so recently elevated above sea-level that its upper surface still shows sun-cracks. The Marquesas and the Tortugas keys are composed of the comminuted, calcareous tests of organisms.

The geologic activity of mangroves in converting shallow submarine banks into land areas was described and illustrated by lantern slide photographs. The fruit of these plants, which is a pod about six to nine inches long, falls into the water and catches on the soft ooze of shallow banks, where the young plants begin to grow, and after developing a tangle of roots below and a tangle of branches above the level of the water, catch and retain any drifting débris.

The speaker then pointed out how fossil corals were utilized in ascertaining the depth and temperature conditions under which geologic formations containing the remains of these organisms were deposited. The restriction of reef-forming corals to shallow water and regions of high temperature, and the existence of a different fauna at depths below 100 fathoms and in regions of cooler temperature, were pointed out.

Dr. Vaughan then briefly outlined the study of the Florida corals, which he is conducting under the auspices of the Carnegie Institution of Washington, with reference to various factors that determine habitat and influence variation. He showed that within the shallow water area of southern Florida there are several different faunal groups of corals that live under different conditions. There are the reef corals proper, largely of massive type, that grow on the barrier reef. Other corals, either of more fragile form of growth with a weaker basal attachment, or with ability to withstand deposits of silt over their upper surface, live on the flats protected from ocean breakers. Other corals of a fragile habit of growth live in channels where they have a continuous supply of pure water and are protected from the breakers. More fragile corals grow at the outer foot of a reef beneath the level of the pounding of the breakers than on the reef proper. The forms that grow at the outer foot of the reef are to some extent similar to those that grow in the channels or along the margin of channels protected from the pounding of the breakers.

The subject of the rate of growth of corals was briefly reviewed and the results of the investigations of Professor J. Stanley Gardiner in the Maldive Islands were given. Professor Gardiner there obtained a collection of corals none of which could have been more than three years of age, and on the basis of these observations estimated that the coral reef might increase one fathom in sixty years. The observations of Gardiner are weak in that he did not definitely know the age of the individual specimens he obtained.

Dr. Vaughan has at present about 200 different coral colonies on which he is making annual measurements to determine the growth rate. The colonies comprise the various conditions under which shallow-water corals grow around the Tortugas, so that the investigations when completed will give the growth rate for each species investigated, and the variation in growth of each species in accordance with the conditions under which it lives in nature. The results of the observations at present indicate that the rate of growth of corals is much more rapid than was previously anticipated, so that in a general way the opinions of Professor Gardiner are substantiated.

The technique of obtaining specimens for planting was briefly described. Besides those colonies that are naturally growing on the reefs or in other localities a number of specimens have been affixed by hydraulic cement to tiles, and the tiles have been planted on the heads of iron stakes driven in selected localities. The tiles can be removed from the stakes, measured and photographed at desired intervals.

Dr. Vaughan also described the technique of rearing coral larvæ and the planting of the affixed young. The larvæ are obtained from living corals brought into the laboratory and kept in jars of water. The planulæ are then pipetted into a jar containing sea-water and a tile on its bottom. After the planulæ have settled the tile is then planted. Some of the tiles with attached larvæ were affixed to iron stakes in the sea and others were attached to the bottom of a floating livecar. It has been ascertained that a *Favia* planula may attain a size of 9 mm. in diameter within a period of seven months.

The duration of the free-swimming larval stage of corals has been carefully studied in order to ascertain the possibilities of drift by ocean currents. The period varies from three or four days to three weeks—periods of ten to twelve days are common. These observations have definitely shown that it is possible for coral larvæ to be drifted great distances by oceanic currents if the temperature conditions are favorable.

D. E. LANTZ,
Recording Secretary

April, 1911